Notice of Allowability	Application No. 09/698,246	Applicant(s) FU ET AL.	
	Examiner Chat C. Do	Art Unit 2193	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *08/15/2006*.
2. ☒ The allowed claim(s) is/are *1-4, 8-57, 60-61, and 66-80 now renumber as 1-71*.
3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☒ Interview Summary (PTO-413), Paper No./Mail Date *attached herein* .
7. ☒ Examiner's Amendment/Comment
8. ☐ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

SUPERVISORY PATENT EXAMINER

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

2. Authorization for this examiner's amendment was given in a telephone interview with Mr. Rob Sokohl Reg # 36,013 on 11/02/2006.

3. The application has been amended as follows:

1. (Amended) An angle rotator for rotating an arbitrary input complex number to produce a rotated complex number according to an input angle θ, said angle rotator comprising:

a memory that stores a sin θ_M value and a cos θ_M value, wherein θ_M is a coarse approximation to said input angle θ;

a first digital circuit that receives a digital signal, wherein a component of said digital signal is represented by the arbitrary input complex number, wherein said first digital circuit performs a coarse rotation on ~~said~~ the arbitrary input complex number based on said sin θ_M value and said cos θ_M value, resulting in an intermediate complex number;

a fine adjustment circuit that generates a fine adjustment value based on a θ_L value, wherein $\theta_L = \theta - \theta_M$; and

a second digital circuit that performs a fine rotation on said intermediate complex number based on said fine adjustment value, resulting in the rotated complex number, wherein at least one component of the rotated complex number is used to generate a signal.

3. (Amended) The angle rotator of claim 1, wherein said first digital circuit is a butterfly circuit having a plurality of multipliers that multiply ~~said~~ the input complex number by said sin θ_M value and said cos θ_M value.

9. (Amended) An angle rotator for rotating an arbitrary input complex number to produce a rotated complex number according to an input angle θ, said angle rotator comprising:

a memory that stores one or more values that are indexed by a most significant word (MSW) of said input angle, including a first value that is an approximation of a sin θ_M value, and a second value that is an approximation of a cos θ_M value, wherein θ_M is a radian angle that corresponds to said MSW of the input angle, and

one or more error values that represent one or more quantization errors associated with at least one of said first value and said second value;

a first digital circuit that receives a digital signal, wherein a component of said digital signal is represented by the arbitrary input complex number, wherein said first digital circuit performs a coarse rotation on ~~said~~ the arbitrary input complex number based on said first value and said second value, resulting in an intermediate complex number; and

a second digital circuit that performs a fine rotation on said intermediate complex number based on said one or more error values, resulting in the rotated complex number, wherein at least one component of the rotated complex number is used to generate a signal.

15. (Amended) The angle rotator of claim 14, wherein said bit storage capacity is N/3 + 1 bits, wherein N is a number of bits that represent a real part of ~~said~~ the input complex number.

16. (Amended) An angle rotator for rotating an input complex number to produce a rotated complex number according to an input angle θ, said angle rotator comprising:

a memory that stores one or more values that are indexed by a most significant word (MSW) of said input angle, including a first value that is an approximation of a sin θ_M value, and a second value that is an approximation of a cos θ_M value, wherein θ_M is a radian angle that corresponds to said MSW of the input angle, and

one or more error values that represent one or more quantization errors associated with at least one of said first value and said second value;

a first digital circuit that receives a digital signal, wherein a component of said digital signal is represented by the input complex number, wherein said first digital circuit performs a coarse rotation on ~~said~~ the input complex number based on said first value and said second value, resulting in an intermediate complex number; and

a second digital circuit that performs a fine rotation on said intermediate complex number based on said one or more error values, resulting in the rotated complex number, wherein at least one component of the rotated complex number is used to generate a signal;

wherein θ_1 is an arcsin of said first value, and wherein said one or more error values include a first error value that is a difference between said second value and said cos θ_1.

26. (Ameneded) An angle rotator for rotating an input complex number to produce a rotated complex number according to an input angle, said angle rotator comprising:

a memory that stores one or more values indexed by a most significant word (MSW) of said input angle, including

a first value that is an approximation of a tan θ_M value, and a second value that is an approximation of a cos θ_M value, wherein θ_M is a radian angle that corresponds to said MSW of the input angle, and

one or more error values that represent one or more quantization errors associated with at least one of said first value and said second value;

a first digital circuit that receives a digital signal, wherein a component of said digital signal is represented by the input complex number, wherein said first digital circuit rotates ~~said~~ the input complex number based on said first value, resulting in an intermediate complex number; and

a second digital circuit that rotates said intermediate complex number so as to produce at least one part of the rotated complex number, based on said one or more error values and said second value, resulting in the rotated complex number, wherein at least one component of the rotated complex number is used to generate a signal.

35. (Amended) In a digital device, a method of rotating an arbitrary input complex number according to a representation of an input angle θ, the method comprising the steps of:

(1) receiving a digital signal, wherein a component of said digital signal is represented by the arbitrary input complex number;

(2) determining a first value that is an approximation of sin θ_M, and determining a second value that is an approximation of cos θ_M, wherein θ_M is a radian angle that corresponds to a most significant word (MSW) of the representation of the input angle θ; and

(3) rotating ~~said~~ the arbitrary input complex number in a complex plane based on said first value and said second value to generate a rotated complex number;

(4) processing a signal by the digital device, wherein said rotated complex number is used to generate said signal.

45. (Amended) In a digital device, a method of rotating an input complex number to produce at least one component of a rotated complex number according to an input angle θ, the method comprising the steps of:

(1) receiving a digital signal, wherein a component of said digital signal is represented by the input complex number;

(2) determining a first value that is an approximation of sin θ_M, and determining a second value that is an approximation of cos θ_M, wherein θ_M is a radian angle that corresponds to a most significant word (MSW) of the input angle θ;

(3) rotating ~~said~~ <u>the</u> input complex number in a complex plane based on said first value and said second value to generate an intermediate complex number;

(4) determining one or more error values that represent one or more quantization errors, including the steps of

(a) determining a first error value that represents a difference between said second value and cos θ_1, wherein θ_1 is an arcsin of said first value, and

(b) determining a second error value that represents (θ_M - θ_m), wherein θ_m = arctan (first value/ second value);

(5) adding said second error value to a θ_L value to produce a θ_l value, wherein θ_L is a radian angle associated with a least significant word (LSW) of said input angle θ;

(6) generating a fine adjustment value based on θ_l and said first error value;

(7) rotating said intermediate complex number in said complex plane to generate at least one component of the rotated complex number based on said θ_l value and said fine adjustment value; and

(8) processing a signal by the digital device, wherein at least one component of the rotated complex number is used to generate said signal.

46. (Amended) An angle rotator for rotating an input complex number to produce an output representing a single coordinate of a rotated complex number according to an input angle θ, said angle rotator comprising:

a memory that stores a first value representing tan θ_M and a second value representing an approximation of cos θ_M, wherein θ_M is an approximation of said input angle θ;

a first digital circuit that receives a digital signal, wherein a component of said digital signal is represented by the input complex number, wherein said first digital circuit performs a first rotation on said input complex number based on said first value, resulting in an intermediate complex number;

means for generating a fine adjustment value;

a second digital circuit that performs a second rotation on said intermediate complex number based on said fine adjustment value to produce an output complex number; and

a scaling circuit that scales said output complex number using said second value to generate the single coordinate output, wherein the single coordinate is used to generate a signal.

48. (Amended) An angle rotator for a direct digital frequency synthesizer, for rotating a selected point in the complex plane according to an input angle θ to generate an output representing a rotated complex number, said angle rotator comprising:

a memory that stores a value representing sin θ_1 and a value approximating cos θ_1, where θ_1 is an approximation of said input angle θ;

a first digital circuit that obtains said value representing sin θ_1 from said memory using a value θ_M to address said memory, where θ_M is an approximation of said input angle θ;

means for generating a fine adjustment value; and

a second digital circuit that performs a rotation of a point in the complex plane whose coordinates are based on sin θ_1 and said value approximating cos θ_1 based on said fine adjustment value, to produce the output representing the rotated complex number, wherein at least one component of the rotated complex number is used to generate a signal.

50. (Amended) An angle rotator for a direct digital frequency synthesizer, for rotating a selected point in the complex plane according to an input angle θ, to generate an output representing a single coordinate of a rotated complex number, said angle rotator comprising:

a memory that stores a value representing sin θ_1 and a value approximating cos θ_1, where θ_1 is an approximation of said input angle θ;

a first digital circuit that obtains said value representing sin θ_1 from said memory using a value based on θ_M to address said memory, where θ_M is an approximation of said input angle θ;

means for generating a fine adjustment value;

a second digital circuit that performs a rotation of a point in the complex plane whose coordinates are sin θ_l and said value approximating cos θ_l, based on said fine adjustment value, to produce one coordinate value of an output complex number; and

a scaling circuit that scales said coordinate value of said output complex number using said value approximating cos θ_l to generate the single coordinate output, wherein the single coordinate output is used to generate a signal.

52. (Amended) An angle rotator for a direct digital frequency synthesizer, for rotating a selected point in the complex plane according to an input angle θ, to generate an output representing a single coordinate of a rotated complex number, said angle rotator comprising:

a memory that stores a value representing tan θ_l and a value approximating cos θ_l, where θ_l is an approximation of said input angle θ;

a first digital circuit that obtains said value representing tan θ_l and said value approximating cos θ_l from said memory using a value representing θ_M to address said memory, where θ_M is an approximation of said input angle θ;

means for generating a fine adjustment value;

a second digital circuit that performs a rotation of the selected point in the complex plane by an angle approximating θ_M, by using said value representing tan θ_l and performing a second rotation of the resulting point in the complex plane, based on said fine adjustment value, to produce one coordinate of an output complex number; and

a scaling circuit that scales said output complex number, using said value approximating cos θ_l, to generate the single coordinate output, wherein the single coordinate output is used to generate a signal.

53. (Amended) A digital signal processing circuit for rotating an input complex number to produce a rotated complex number according to an input angle θ, said circuit comprising:

a first digital circuit that generates a normalized input angle from a value representing the input angle θ;

a second digital circuit for stripping a plurality of most significant bits of said representation of the normalized input angle to obtain a temporary angle τ;

determining means for determining, from τ, whether the normalized input angle represents an angle that is in an even or odd quadrant or octant; and

2's complement negate means for selectively negating the bits remaining after said stripping of most significant bits from the normalized input angle by selectively performing a 2's complement negate operation on said remaining bits;

wherein a resulting angle φ is equal to temporary angle τ if said input angle is in an even quadrant or octant, and said resulting angle φ is equal to the 2's complement negation of temporary angle τ if said input angle is in an odd quadrant or octant.

<u>mean for rotating the input complex number according to the resulting angle φ to produce the rotated complex number, wherein at least one component of the rotated complex number is used to generate a signal</u>.

54. (Amended) In a digital device, a ~~A~~ method of rotating an input complex number to produce an output representing a single coordinate of a rotated complex number according to an input angle θ, comprising the steps of:

storing in a memory a value representing tan θ_M and a value representing an approximation of cos θ_M, wherein θ_M is an approximation of said input angle θ;

performing a first rotation on ~~said~~ <u>the</u> input complex number based on said value representing tan θ_M, resulting in an intermediate complex number;

generating a fine adjustment value;

performing a second rotation on said intermediate complex number based on said fine adjustment value, to produce an output complex number;

scaling said output complex number, using said approximation of cos θ_M, to generate the single coordinate output; and

processing a signal by the digital device, wherein the single coordinate output is used during said processing.

66. (Amended) The angle rotator of claim 1, wherein said first digital circuit processes a digital binary representation of ~~said~~ <u>the</u> arbitrary input complex number.

67. (Amended) The angle rotator of claim 9, wherein said first digital circuit processes a digital binary representation of ~~said~~ <u>the</u> arbitrary input complex number.

71. (Amended) The angle rotator of claim 1, wherein said first digital circuit processes a digital binary representation of ~~said~~ the input complex number, with the real part and the imaginary part of the input complex number each having N bits, with N $\geq$ 9, and wherein said processing based on said $\sin\theta_M$ and $\cos\theta_M$ values employs binary representations of $\sin\theta_M$ and $\cos\theta_M$ in which the number of bits in the representation of the $\cos\theta_M$ value is at least $1.5\times K$, where K is the number of bits used in the representation of the $\sin\theta_M$ value.

72. (Amended) The angle rotator of claim 9, wherein said first digital circuit processes a digital binary representation of ~~said~~ the input complex number, wherein said first value has a precision of K bits and said second value has a precision of at least $1.5\times K$ bits.

75. (Amended) The angle rotator of claim 16, wherein said first digital circuit processes a digital binary representation of ~~said~~ the input complex number, with the real part and the imaginary part of the input complex number each having N bits, with N $\geq$ 9, and wherein said processing based on said $\sin\theta_M$ and $\cos\theta_M$ values employs binary representations of $\sin\theta_M$ and $\cos\theta_M$ in which the number of bits in the representation of the $\cos\theta_M$ value is at least $1.5\times K$, where K is the number of bits used in the representation of the $\sin\theta_M$ value.

76. (Amended) The angle rotator of claim 26, wherein said first digital circuit processes a digital binary representation of ~~said~~ the input complex number, wherein said first value has a precision of K bits and said second value has a precision of at least $1.5\times K$ bits.

77. (Amended) The angle rotator of claim 46, wherein said first digital circuit processes a digital binary representation of ~~said~~ the input complex number, wherein said first value has a precision of K bits and said second value has a precision of at least $1.5\times K$ bits.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue

fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Chat C. Do whose telephone number is (571) 272-3721. The examiner can normally be reached on 7:00AM to 5:00PM M-Th.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Meng-Ai An can be reached on (571) 272-3756. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Chat C Do
Examiner
Art Unit 2193

November 9, 2006

MENG-AI T. AN
SUPERVISORY PATENT EXAMINER